AU/ACSC/LaPietra, C/AY10

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The Aging Arsenal

The Stockpile Stewardship Program and Long Term Challenges to Viable Deterrence

by

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A Research Report Submitted to the Faculty

In Partial Fulfillment of the Graduation Requirements

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Maxwell Air Force Base, Alabama

March 2010

Disclaimer

Abstract

After the dissolution of the Soviet Union, the U.S. nuclear program changed dramatically as the role of nuclear weapons rapidly diminished and nuclear weapon development gradually halted. This change, paired with the end of nuclear testing in 1992, fomented an initiative known as the Stockpile Stewardship Program (SSP). A primary focus of this program is to maintain the stockpile through the use of experimentation and advanced simulation and surveillance tools instead of underground testing. The SSP has provided significant investment in the nuclear complex, particularly with respect to sub-critical testing and analysis that has contributed to a greater understanding of nuclear weapons. Sole reliance on the SSP to maintain the US nuclear capability has had unintended consequences that could ultimately degrade the readiness of the nuclear force. These include the physical aging of the stockpile, antiquated and inadequate design features, and a waning of expertise and deteriorating infrastructure. This paper examines these issues and investigates both sides of the argument for the development of a new nuclear warhead as a first step towards the gradual replacement of the stockpile.

After the fall of communism and the dissolution of the Soviet Union, the U.S. nuclear program changed dramatically as the role of nuclear weapons rapidly diminished and nuclear weapon development gradually halted. This change, paired with the end of nuclear testing in 1992, fomented an initiative to ensure an acceptable degree of confidence in the nuclear arsenal. The result was the Science-Based Stockpile Stewardship program, started in 1993, which later became known as the Stockpile Stewardship Program (SSP). A primary focus of this program is to maintain the stockpile through the use of experimentation and advanced simulation and surveillance tools instead of underground testing.[1] While the success of the SSP is undeniable, there is growing concern that this success will not last forever and the existing warheads will eventually exceed even their extended service lives. The long term continuation of relying solely on the SSP to maintain the US nuclear capability has had a few unintended consequences that could ultimately degrade the readiness of the nuclear force. These include the physical aging of the stockpile, antiquated and inadequate design features, and a waning of expertise and deteriorating infrastructure. This paper will examine these issues and investigate both sides of the argument for the development of a new nuclear warhead as a first step towards the gradual replacement of the stockpile.

The first issue regarding the effects of maintaining and sustaining an aging stockpile presents not only a technical challenge, but a financial one as well. The SSP has successfully modernized many of the components on the warheads to maintain a safe and reliable stockpile. This process typically works well for relatively short durations; however as with any weapon system, sustainment becomes increasingly difficult and costly as the availability of replacement components diminishes. Furthermore, since the existing warheads were designed for a particular operational life cycle with the expectation of being retired and replaced by a new warhead at the

end of that cycle, the sustainment effort presents a significant challenge. The designs resulting from the Cold War operating and sustainment concepts focused almost exclusively on maximizing the warhead yield to weight ratio often at the expense of maintenance and sustainment considerations. As a consequence, some of the inspections and repairs required to maintain the stockpile today are exceptionally difficult to accomplish since such actions were never anticipated. A final aspect of the challenges created by continuing to maintain an aging stockpile is the cumulative effects of decades of maintenance and modifications. One of the most obvious concerns centers on the effects of aging on the critical components of the weapons. When a problem is discovered with a weapon, a Significant Finding Investigation (SFI) is conducted to determine the possible cause and the severity of the issue. In recent years, the number of SFIs due to age-related issues has increased and several experts expect this trend to continue.[2] This does not suggest the stockpile is on the verge of failure; however it certainly presents a legitimate concern regarding the long term health of the stockpile. Furthermore, some of the laboratory directors have attributed the current process of component remanufacturing to a gradual increase in the uncertainty of the expected operational reliability of the weapons.[3]

Another issue is the continued reliance on older warheads that lack some of the modern safety and security features found in later generation weapons. Refurbishment of the older warheads has mitigated some of the risk; however some features are too costly or difficult to retrofit onto old warheads and therefore require new production. There are three modern safety features specified in the FY93 Energy and Water Development Appropriations Act that are desired for all U.S. weapons: Enhanced Nuclear Detonation Safety (ENDS), Insensitive High Explosive (IHE), and Fire-Resistant Pit (FRP).[4] The ENDS feature is designed to prevent unintentional nuclear detonation by requiring several conditions to be met before allowing the

firing signal to cause a nuclear detonation. The IHE and FRP features serve to reduce the possibility of detonation caused by shock, impact, or fire. The vast majority of the warheads currently in the inventory have the ENDS features; however only a small portion of the warhead designs also incorporate IHE and an FRP. In some cases the lack of these features is simply a factor of when the warheads were designed since these materials are modern innovations. In other instances these features were intentionally omitted since they reduced the warhead's yield to weight ratio. As the stockpile continues to age, the safety liability imposed by the warheads without all three modern safety features will continue to grow, particularly with increased maintenance and handling activities.

Finally, prolonged implementation of the SSP without any new production efforts has resulted in an atrophy of certain areas within the nuclear complex. While the SSP is focused on monitoring, modernization and refurbishment of the nuclear stockpile it does not address or alleviate potentially debilitating deficiencies within the nuclear complex that produced the warheads years ago. The impacts of the shift in focus as the result of the SSP can be seen in two distinct forms. The first is the physical infrastructure in which the weapons are designed, produced, and maintained. In many cases, the buildings and equipment used today date back to the Manhattan Project and have been subject to long periods of neglect.[5] The second impact is the degradation of the intellectual infrastructure needed to maintain a healthy and vibrant nuclear capability. Many of the scientists and engineers with firsthand knowledge and experience in weapons production are reaching retirement age creating a "brain drain" of production capabilities. Compounding this challenge are difficulties in recruitment and retention of high quality talent to replace the retiring workforce. As a result of the impact on the physical and

intellectual infrastructure, some capabilities in production engineering may be lost, possibly requiring decades to replace them should the need arise in the future.[6]

The issues of safely maintaining an aging stockpile, continuing to operate designs that are outdated in some aspects, and a nuclear complex that is gradually losing its responsive capabilities present significant challenges to senior military and political leaders. In order to pursue the best solution, it is necessary for these leaders to first decide if nuclear weapons will continue to have a role in U.S. defense policy. If answered in the affirmative, then the issue focuses on the number and type of weapons necessary to support the policy. These questions present three possible scenarios, the first of which implies the elimination of all U.S. nuclear weapons, a second that continues long term reliance on the current stockpile, and a third that requires design and production of new nuclear weapons. Unless new technology is developed that renders nuclear weapons obsolete, the first scenario is unlikely since one can expect the U.S. to maintain its nuclear capability as long as similar capabilities exist elsewhere in the world. The second scenario is equally untenable since it suggests the current stockpile can operate indefinitely. Continued operation and sustainment of such old weapons would be expensive and involve elevated risk due to the increased uncertainties from multiple refurbishments as mentioned above. Developing and producing a new nuclear warhead as described in the third scenario would certainly present significant technical and political challenges; however it is the only option that provides a safe and reliable nuclear capability well into the future.

In 2005, the Nuclear Weapon Council initiated a study to develop a new design for a warhead that incorporated modern safety and security features, could fit in three different reentry bodies and was easier to manufacture and maintain than existing warheads.[7] Furthermore, the new Reliable Replacement Warhead (RRW) design would be produced without the benefit of

nuclear testing due to the US voluntary moratorium on nuclear testing. In March 2007 the design produced at Lawrence Livermore National Laboratory (LLNL) was selected and a projected initial operational capability was set for 2012. Only two years after LLNL was selected, the RRW program was cancelled as the result of intense political and fiscal pressures. Many opponents of the program suggested the RRW was either unnecessary to maintain the nuclear capability or that it was simply incompatible with current U.S. policy and the geopolitical environment.

Those who insist the RRW is unnecessary often highlight the success of the Stockpile Stewardship Program in maintaining an annually certified capable and credible nuclear deterrent. With over $6.3B appropriated for nuclear weapons activities in the FY2010 budget[8] and similar amounts in previous years, there have certainly been great advances in testing, simulation, and sustainment efforts. One example of this investment is the National Ignition Facility (NIF) where researchers will be able to examine the characteristics of a thermonuclear burn in the high energy density regime without an underground nuclear test. In essence, the NIF will create a small nuclear explosion with most of the corresponding characteristics except the total explosive energy yield is approximately the same as only one gallon of gasoline.[9] This small yield will allow scientists to obtain much more accurate and sensitive measurements of the reaction.

Investment has also been made in facilities necessary to study the low energy density regime leading up to a nuclear reaction. The Dual Axis Radiographic Hydrotest (DARHT) facility allows scientists to obtain high quality imagery of sub-critical tests utilizing a heavy metal surrogate in place of the nuclear fuel. As a result, warhead modifications can be tested using all of the non-nuclear components in an operationally representative configuration and

imagery and measurements can be used to determine if the system created the proper conditions for a supercritical reaction.

The NIF and DARHT facilities provide a CTBT compliant capability to test existing warheads and potential modifications in both the subcritical regime and some aspects of the supercritical regime, thus supplying a nearly complete assessment of the weapon's functionality. This sense of awareness encourages some to believe the SSP can be used to maintain the existing warheads for several decades into the future and therefore any new development or production is an unnecessary expense.

In response to such claims, supporters of the RRW or similar programs certainly believe the exceptional test capabilities and extensive sustainment efforts provide an accurate assessment of the stockpile and a means to address deficiencies as they arise; however these capabilities and efforts do not address the fact that the basic warhead designs are several decades old and have inherent limitations. A new warhead design could incorporate numerous advances and emphasize longevity and sustainability rather than continue the current painstaking, piecemeal process of incremental repair and modification.

Another perspective provided by opponents to new warhead production is that such actions would be incompatible with current U.S. policy and the geopolitical environment. Some suggest that new development and production efforts would undermine U.S. efforts to halt nuclear proliferation due to an air of hypocrisy that would reduce its leverage against nations like North Korea and Iran. Additionally, opponents insist a reinvigorated nuclear weapons complex would set an aggressive tone with near peer competitors such as Russia and China that could lead to a limited arms race. Finally, there is concern that a new development program would require nuclear testing, an act that would violate our voluntary moratorium on nuclear testing and

possibly postpone indefinitely the CTBT entry into force.and possibly unravel international adherence to the treaty all together.

All of these concerns are certainly relevant in today's geopolitical environment, but supporters of new production and revitalization of the nuclear complex maintain that such concerns can be addressed and overcome with technical and diplomatic expertise. The expectation that a new warhead design will require nuclear testing in the future may seem logical; however, a new design would incorporate well understood and characterized materials and technology with increased performance margins in an effort to preclude the need for nuclear testing.[10] Facilities such as the NIF and DARHT can be utilized to provide a high degree of confidence in new weapon performance just as it does for existing weapons today.

Additionally, extensive diplomatic efforts must be made to assure all skeptics, both domestic and international, that any new warhead designs will not provide new operational capabilities and will not increase the overall inventory. In fact, the introduction of a new warhead would likely enable a reduction in the inactive stockpile since the new weapons would require fewer reserve warheads to provide a technical hedge.

One factor that is often overlooked as this debate takes place in the military and political realm is time. For those who believe the U.S. should develop and produce a new warhead, the degree of urgency depends heavily upon the life expectancy of the stockpile. For example, if the expectation is that the current inventory will be viable for the next 50 years some would consider new warhead development and production an extremely low priority. While 50 years may seem like the distant future, it is not such a long duration with respect to the acquisition cycle. Analysis of the development and production cycles for the warheads currently in the inventory (see appendix) indicates the average time from program initiation to the start of full rate

production is approximately 5.5 years. It is important to consider the fact that this average cycle was achieved at a time when the expertise was fresh, the production facilities were consistently utilized (i.e. “warm” production line), and the security environment provided for exceptional political and economic support. In today’s political/economic landscape, this same process would take significantly longer, especially if the physical and intellectual infrastructure of the nuclear complex continues to weaken.

With this in mind, it is not unreasonable to conclude that the program initiation and development cycle for a new warhead could easily grow to approximately 20 years. Subsequent development efforts would be shorter; however the time required to ultimately replace the current weapons and maintain a variety of designs as a technical hedge would quickly approach 50 years. Inevitably, proper timing will be a major consideration for any proposed new nuclear weapon program since a prolonged delay may result in a capability shortfall while conversely, a plan offered too early will not likely receive funding due to a perceived lack of urgency. Therefore it is necessary to start a new program well before the situation becomes dire.

The Stockpile Stewardship Program has maintained the readiness of the U.S. nuclear capability at a relatively low cost for almost 20 years. As a result, there has been a significant investment in the nuclear complex, particularly with respect to sub-critical testing and analysis that has contributed to a greater understanding of the operation and sustainment of the nuclear weapon stockpile. The benefits of the program are obvious; however the effects discussed in this paper suggest a new course of action is necessary. The challenges and sensitivities of the current geopolitical environment should not cause leaders to ignore the inevitable effects of an ever-aging stockpile.

[1] *Nuclear Matters: A Practical Guide*, Office of the Deputy Assistant Secretary of Defense for Nuclear Matters, 51.

[2] William J. Perry and James R. Schlesinger, *America's Strategic Posture: The Final Report of the Congressional Commission on the Strategic Posture of the United States,* (Washington, D.C.: United States Institute Of Peace Press, 2009), 40.

[3] K. Henry O'Brien et al., *Sustaining the Nuclear Enterprise - A New Approach*, Lawrence Livermore National Laboratory, UCRL-AR-212442, LA-UR-05-3830, SAND2005-3384, May 2005, 4.

[4] *Nuclear Matters*, 5.

[5] Perry and Schlesinger, *America's Strategic Posture,* 48.

[6] Ibid., 53.

[7] Nuclear Weapons Complex Assessment Committee, *The United States Nuclear Weapons Program: The Role of the Reliable Replacement Warhead* (Washington, DC: American Association for the Advancement of Science Publication Services, 2007), 17.

[8] National Nuclear Security Administration, *Supplement to the Stockpile Stewardship Plan: Fiscal Years 2010-2014* (Office of Defense Programs, Washington, DC, December 2009), 17.

[9] "NIF and National Security," *Energy & Technology Review, December 1994*, 25-26.

[10] K. Henry O'Brien et al., *Sustaining the Nuclear Enterprise*, 7.

Appendix

Warhead	Development Start	Production Start	Development Duration
W62	Jun-64	Mar-70	5.75
W78	Jul-74	Sep-79	5.17
W87	Feb-82	Jul-86	4.41
W76	May-73	Nov-78	5.51
W88	Mar-84	Apr-89	5.09
B61-0	Aug-60	Jan-67	6.42
B61 3/4/5	Apr-72	Aug-79	7.34
B61- 7	May-79	Sep-85	6.34
B61- 11	Aug-95	Jan-97	1.42
B83	Jan-79	Sep-83	4.67
W80-1	Jun-76	Feb-82	5.67
W80-0	Jun-76	Mar-84	7.75
	Average Development Time (years):		**5.46**

Source for dates: http://nuclearweaponarchive.org/Usa/Weapons

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